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Equipment and Techniques for Handling Northern Fur Seals

Roger L. Gentry and John R. Holt

July 1982

U.S. DEPARTMENT OF COMMERCE
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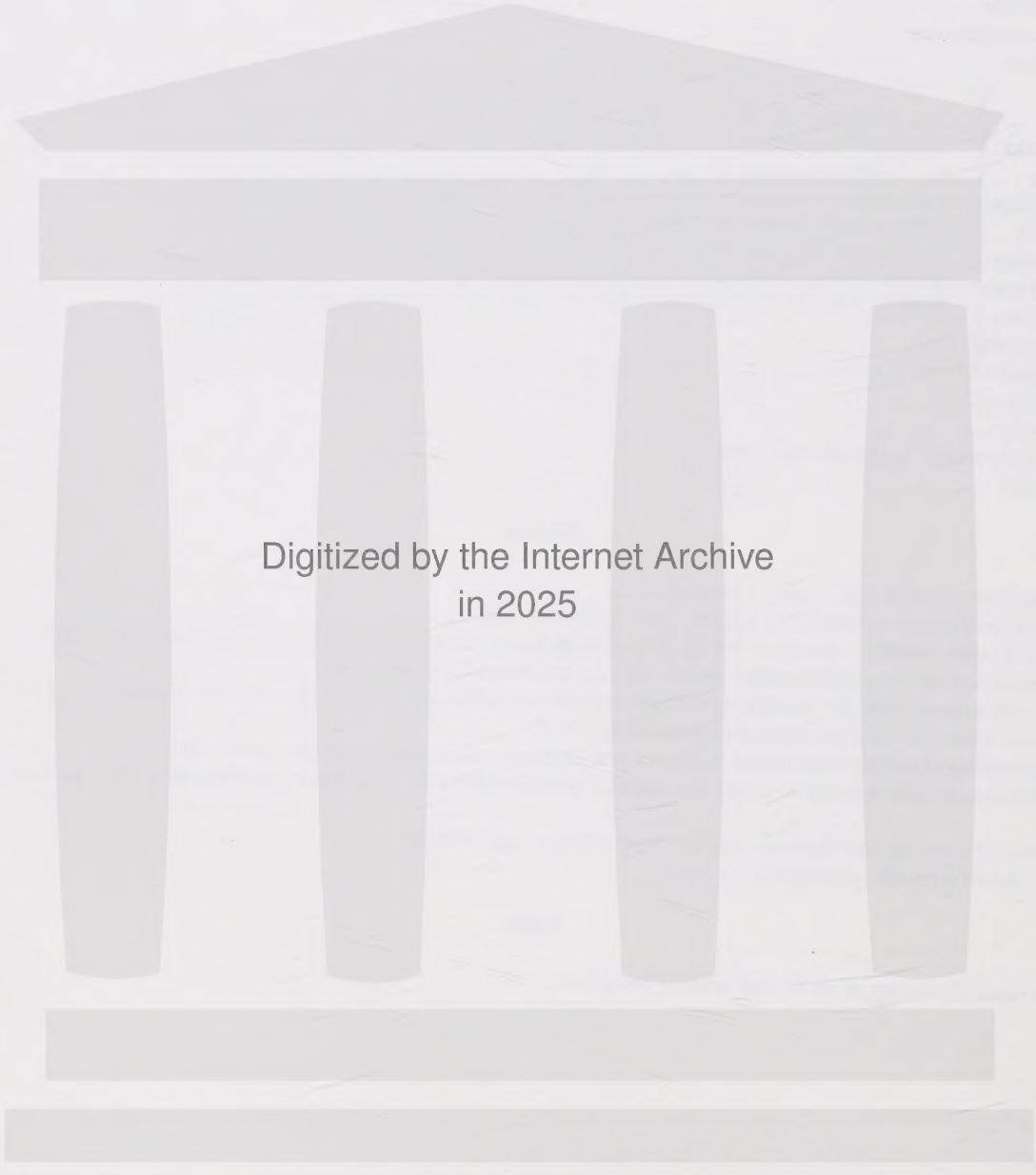

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Equipment and Techniques for Handling Northern Fur Seals

ROGER L. GENTRY and JOHN R. HOLT[1]

ABSTRACT

This paper describes techniques for capturing, immobilizing, and marking northern fur seals, *Callorhinus ursinus*, of all ages and both sexes. It is intended as an explicit field manual for handling this species, and as a source of ideas for handling other eared seals, wild or captive. Furthermore, it advocates capturing and manipulating wild seals as an approach to investigating behavior. The paper deals only with short term physical restraint; immobilization with drugs is not considered. Emphasis is placed on the importance of animal behavior in determining the design of capture equipment and techniques. Because of this dependence, capture techniques must change seasonally as behavior changes, and different techniques may be needed for different species. A wide range of techniques is considered, from the capture of single pups to the mass captures of adult females.

INTRODUCTION

Field studies on the Otariidae (fur seals and sea lions) have not matured beyond the level of passively observing wild populations (Gentry 1975). The limitations of this approach are obvious; it will never reveal cause and effect relationships, and it will not serve for detailed hypothesis testing. Without adopting more complex field methodology otariid studies are not likely to match the level of sophistication reached in primate field studies (compare Ronald and Mansfield 1975 against Chevalier-Skolnikoff and Poirier 1977).

The use of manipulative field experiments by primatologists marks the difference between the two disciplines. Otariid researchers too can perform experiments on wild animals given a set of handling techniques, some simple tools, and the conviction that small disturbances are justifiable. Obviously, not every animal of every species can be manipulated. But at least some animals of most species can be. The subject of this manual, the northern fur seal, is one of the more tractable otariids.

The equipment and techniques described here were developed during the past 8 yr. Some of the methods have been used successfully on the Afro-Australian fur seal, *Arctocephalus pusillus pusillus*, and the Antarctic fur seal, *A. gazella*. With modifications, the techniques and equipment could be used on other otariids as well. Some of the equipment we describe have had a long history of successful use in the Pribilof Islands, and some we have invented. We developed the techniques for using this equipment around two criteria specific to our behavioral studies: 1) the methods of capture and handling a given animal should cause the least possible disturbance to other seals and 2) the prolonged debilitating effects of drugs are to be avoided. Because other workers will have different criteria, this manual presents convenient starting points for the development of techniques that meet other criteria. That is, our techniques are not offered as "correct," only successful.

We intend this as a field manual for those who have had no previous experience with otariids and who must capture and handle animals without the aid of experienced help. The immobilization techniques are applicable to any captive otariids. All the equipment we describe can be built and maintained in the field with minimal tools. Techniques for keeping seals in captivity have recently been reviewed (Spotte 1980).

IMPORTANCE OF BEHAVIOR

The key to successfully handling wild otariids is knowing their behavior thoroughly. Knowing their strengths and weaknesses often suggests a design for some special equipment. But more importantly, knowledge of how animals act reduces one's fear of the animals and fosters the calm judgement under stress that capture situations demand. Inevitably, judgement is most important at the moment of greatest physical exertion during a capture. The use of too much force can injure or kill the seal, but insufficient force can allow the seal to escape and endanger humans. A knowledge of behavior gives one the judgement to maintain a balance between force and finesse, and the flexibility to improvise during captures. No two animals are exactly alike, and no one set of procedures works equally well in all captures. Furthermore, the behavior of animals changes throughout the year so extensively that seasonal changes in capture techniques are required for a given age and sex (Table 1).

Most of the techniques in this manual take advantage of some special behavioral trait of northern fur seals. If a different species does not share that trait the technique will not work as described. However, the approach to developing techniques should be the same for all species. Basically, one learns the behavioral traits well, and then uses those traits for their direct effect, or selectively avoids them. For example, northern fur seal males aggressively charge a human in response to a direct, fixed stare. Charging is desirable when trying to lasso the seal properly, and it can be induced by staring. In contrast, charging is not desirable when capturing adult females from within the male's territory, and it may be prevented by averting the face from the male. Where possible we advocate capture by trickery, rather than by force.

There are four generalizations about otariid behavior that influence handling techniques and equipment. First, the animals will not attack a human with the same determination as they would another seal. It is usually not appropriate to bolt and run from an attack, rather to cautiously withdraw. Overreaction to attack can jeopardize your coworkers. Second, otariids are physically strongest in the vertical direction due to the development of their pectoral muscles. They are powerless on their backs or suspended in the air. Unlike phocids they are relatively weak in side-to-side motions, and the design of restraint

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Table 1.—Abbreviated chronology of the fur seal breeding season.

Date	Comments
Mid-May	First territorial adult males arrive.
Late May	First juvenile males arrive along beaches and on haulout grounds. Best time to capture adult males on territory.
Early June	First females arrive and form small groups along water's edge. Arrival of new territorial males decreases sharply.
Mid-June	Large juvenile males appear around periphery of breeding areas; number of juvenile males on hauling grounds increases.
Late June	Females far enough inland and births are frequent enough to allow female captures (noose method) on inland borders of breeding areas.
5 July	Peak of pupping season; best time to capture adult females using noose method.
12-15 July	Peak of copulations.
25 July	Births too infrequent and females too wary to permit captures with a noose. Use hoop net technique. Territorial males abandon territories and can be captured by hoop net; 2-yr-old juvenile males arrive.
Early August	Small adult males begin short tenures on territories. Mass captures of females and pups is now possible. Females begin to appear on hauling grounds.
Late August	Many females on hauling grounds, most large males absent.
Late August, early September	Yearling juvenile males arrive; older juveniles move onto breeding areas. All pups of the year entering the sea.
Mid-September	Virtually all males absent, no territorial structure.
Mid-October	Females begin to wean pups of the year and leave the island for the season.
Mid-November	Very few animals remain.

equipment can exploit this fact. Third, despite their lack of lateral power, their biting motions are quickest in that direction. Exercise extreme caution while working around the necks, ears, or front flippers of unrestrained seals. Last, when they bite they usually make a single tearing slash at the very surface of their target. People handling northern fur seals are spared some injury by wearing loose-fitting rain clothing which the seals bite first.

DESCRIPTIONS OF EQUIPMENT

Noose Pole (or Choker) (Fig. 1)

This is the most broadly applicable gear used in handling fur seals. It consists of a loop of rope at the end of a light-weight pole. The loop goes over the animal's head and is twisted tightly by rotating the pole around its long axis. When properly applied the choker prevents the animal from fleeing or attacking. It allows a single person to restrict the movements of seals weighing up to 60-65 kg, including adult females and 3-4 yr-old males. A second person grasping the hind flippers is required for lifting the animal or moving it more than a few meters. For holding seals motionless a restraint bar is recommended (described below).

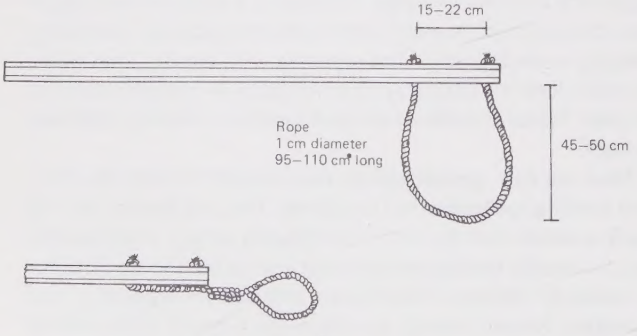


Figure 1.—A noose pole or choker used to control small fur seals. The open loop is placed over the animal's head and the handle is rotated until the loop tightens around the seal's neck. See also Figure 10.

The poles are most frequently cut from 4 cm × 4 cm clear fir (2 in × 2 in dimension lumber) of varying lengths determined by the application. Corners of the lumber are beveled to an octagonal shape to reduce weight and improve the grip. The rope forming the noose is typically 1 cm (3/8 in) hemp. The rope is threaded through two holes drilled 15-23 cm (6-9 in) apart near the end of the pole and knotted on the opposite side. The rope loop is 95-105 cm (38-42 in) long, providing a loop 45-50 cm (18-20 in) deep.

In making chokers, a balance is struck between weight and strength; good quality lumber is essential. Breakage usually occurs in poles with knots. Animals snapping at the choker or noose may bite through the rope or gradually chew away the end of the choker pole, so that it is weakened or the rope noose may pull out. For these reasons it is advisable to have a spare choker on hand. Also for these reasons it is not advisable to use the metal nooses (commercially available) used to handle dogs. For restraining animals already contained in a holding pen or transport box, a 2-2.5 m (6-8 ft) long choker provides a good combination of physical control, safe working distance, and convenience for working in confined spaces. Longer chokers (up to 5 m) are used for other applications, such as capturing adult females on the rookery.

Bamboo Poles

These are used in varying lengths for fending off aggressive animals or for herding groups of animals. Poles 5 m long are appropriate for adult males, but shorter lengths may be used when working with smaller animals. The bamboo provides a good combination of light weight and high compression strength. The best defense with these poles is a pushing or jabbing motion aimed at the chest or throat.

Diagonal wraps of fiber glass (strapping) tape with considerable overlap at the ends of the pole, but with 5-10 cm between wraps near the middle add strength to the pole and greatly decrease splitting. Bamboo stored in a dry, heated building may split badly enough to be useless. With a lightweight cord loop at one end, a bamboo pole makes an effective long choker for snaring fur seal pups.

Restraint Bar (or Board) (Fig. 2)

This device is used for holding small animals stationary, by restraining the head so that marks or tags can be applied, harnesses can be fitted, or other physical manipulations accomplished without danger of the workers being bitten. The restraint bar consists of a heavy wooden plank, and a wooden yoke in the shape of an upright U. A metal bar is attached with a pivot at one end of the plank so that the bar can close down on the plank scissors-fashion. The bar has an inverted U or yoke near its center which fits over the animal's neck and into the wooden yolk to form a circle around the animal's neck when the bar is closed. Both the wooden yoke and the U shape in the metal bar may be fairly broad, typically 18 cm wide and 13 cm deep (7 × 5 in). When the bar is closed, the opening between the bar and the wooden yoke should be about 10 cm (4 in). The wooden yoke is generally made of two pieces of 5 cm (2 in) dimension lumber laid out parallel on the base plank about 2.5-5 cm (1-2 in) apart, so that when the metal bar closes down, it falls between the two wooden yoke pieces and can lie flat against the base plank. The plank is 5 × 20 cm (2 × 8 in) dimension lumber. The bar is made from 2 cm inside diameter iron pipe (3/4 in plumbing stock) or thick-walled electrical conduit. Metal conduit is much more easily bent to the sharp curves necessary: kinks in the pipe drastically reduce the strength and life-span of the bar.

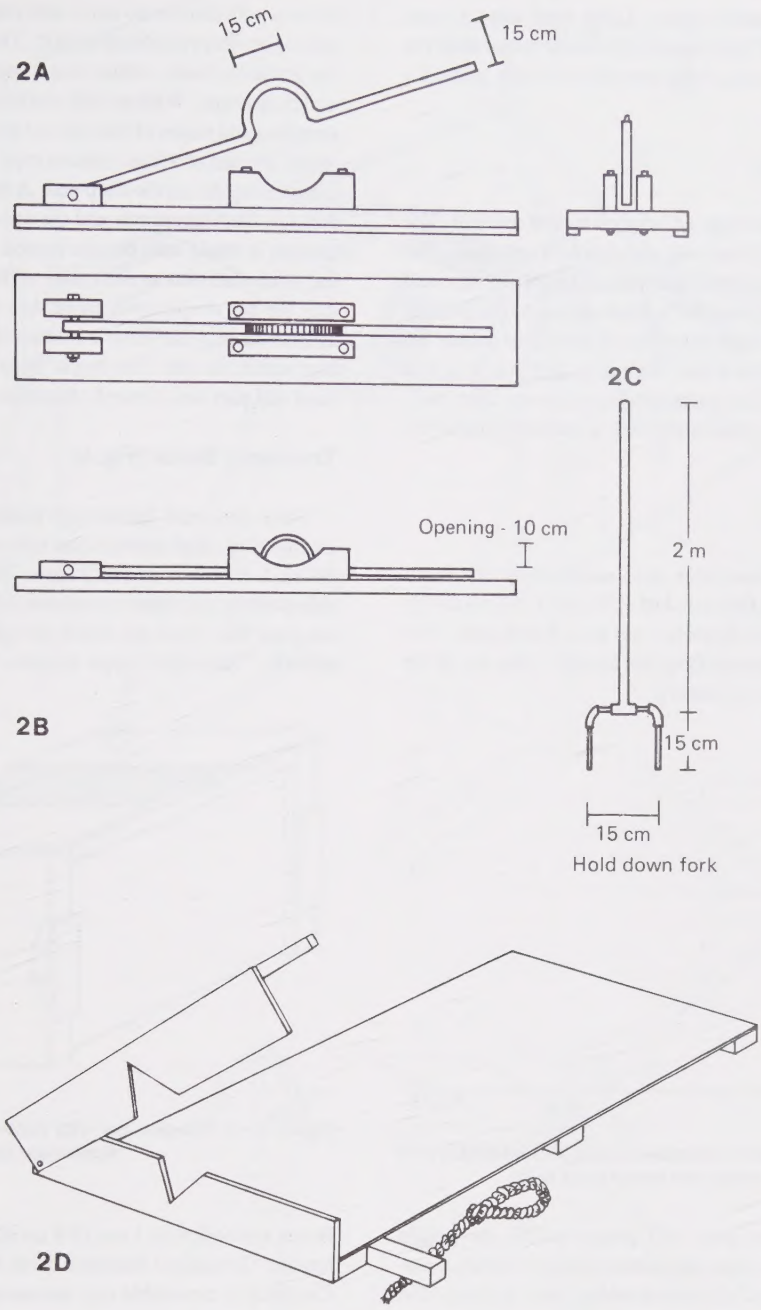


Figure 2.—Restraint devices used to immobilize small to medium sized fur seals. A) A bar with a deep yolk which restrains by preventing the animal from backing up. B) A bar with a shallow yolk which restrains by pressing down on the seal's neck. C) A hold-down fork that pins the animal's head to the ground using hand pressure only. D) A board with "V" notches which wedge behind the skull and prevent the animal from backing up.

This bar provides restraint by producing downward pressure on the animal's neck. The sides of the inverted U and wooden yoke prevent the animal from turning its head from side to side, so that the animal can escape only by "backing out" of the bar. Downward pressure on the bar may restrict the animal's air passage, and inhibit breathing. For this reason one person must always attend the seal, varying the pressure on the bar to maintain a balance between restraint and asphyxia. This person must be familiar with symptoms which seals display under physical and physiological stress. This device is strong and portable, but large, strong seals can stand up with the restraint bar around their necks.

Another version of the restraint bar (Fig. 2d) uses a plywood board with two vertical plywood "blades" attached to one end. The upper blade is hinged at one side and passes in front of the attached lower blade when closed. Each blade has a 65° angle V notch, 20 cm (8 in) deep, cut in its center so that the closed blades create a diamond shaped opening. Restraint results from the opening being adjusted around the neck so that the skull cannot be withdrawn backward through the diamond. The upper blade can be tied in place, and straps can be placed over the seal so that the animal need not be attended continually. The seal's airway cannot be obstructed by downward pressure because of the depth of the lower V notch. This board can be

lifted so that the seal can be carried about. Large seals cannot stand up in this device because they push against the board rather than the ground. Milk samples can be taken from restrained females through a sliding door under the teats.[2]

Hold-Down Fork (Fig. 2c)

This is a 2 m long metal pole with a U-shaped fork at one end. The prongs of the fork are about 15 cm long and about 15 cm apart. The entire device can be constructed from galvanized plumbing pipe and pipe fittings. It is used to pin the head of a small animal to the ground. It may be used in place of a hold-down bar in situations where the animal must be held in position at the location of capture. It is best applied when the animal must be restrained for only very short periods of time. Restraint with the hold-down fork is not nearly as secure as with the restraint bar.

Nets

Large hoop nets (Fig. 3) have been used successfully in various applications. The basic hoop, fabricated of 3.75 cm (1 1/2 in) aluminum tubing is 0.75 m (30 in) in diameter, and has a 4 m handle. Two 30 cm long diagonal braces extend from the handle to the rim of the hoop (not quite tangent to the perimeter).

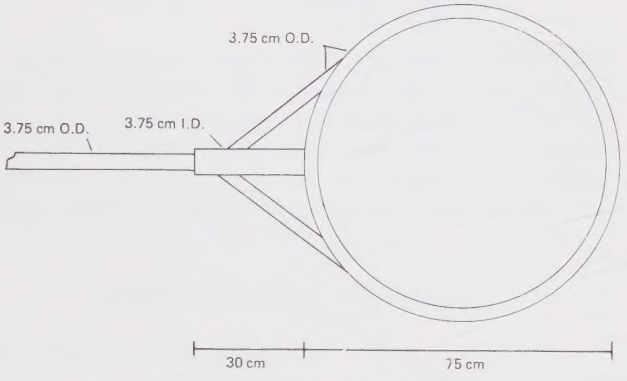


Figure 3.—A hoop net with a handle of aluminum tubing inserted inside a piece of aluminum pipe welded and braced to the hoop.

Proper construction of this hoop will greatly reduce its weight without loss of strength. Our most satisfactory design combines aluminum pipe (thick walled) and aluminum tubing (thin walled). The circular hoop and diagonal braces are made of tubing. Into a short "handle" (about 30 cm) of aluminum pipe attached to the hoop is inserted a longer (3 m) handle of aluminum tubing. This arrangement weighs little but provides sufficient strength at the point of maximum stress where the handle meets the hoop.

Nets of varying dimensions and weights are attached to this hoop depending upon the size of animals to be caught. The most frequently used net type is nylon or polypropylene fishing net with roughly 10 cm mesh openings.

For capturing adult females and small subadult males, a net with a slight taper and a depth of 1.25-1.5 m is appropriate. Pups may be caught with this net also, but if numerous pup captures are to be made, a smaller hoop and net will be less cumbersome.

For capturing large subadult males weighing 135-160 kg (300-350 lb), just smaller than adult territorial males, the net should be about 2 m deep with little or no taper. Into the foot of this net is sewn a bag of canvas or fiber-reinforced plastic. The purpose of the bag is to restrict the animal's vision, which encourages it to rest more quietly while under restraint. Without this restriction the animal will continue to struggle, and males of this size are too strong to be restrained by force alone. Instead of a bag, a sleeve may be used with grommets installed along its border on the deep end. A strong purse string may be woven through these grommets and the ends of the net outside the bag. The capture is made with the net pursed. The bag is 60-75 cm deep and the same diameter as the inside of the net. The bag should be sewn into the net deeply enough so that when a captured animal pushes against the bag, the force is restrained by the strong net and not by the bag within the net. The bag is deep enough to go over the animal's head and part way down it shoulders.

Transport Boxes (Fig.4)

These are small lightweight boxes with wire mesh tops used for transporting small animals that two people can carry. Dimensions are 60 cm × 60 cm × 80 cm (24 in × 24 in × 32 in) and allow comfortable posture and some movement for an adult female, with space for her pup. The boxes are small enough to be loaded easily on a small aircraft. "Stretcher" type handles are removable to save space.

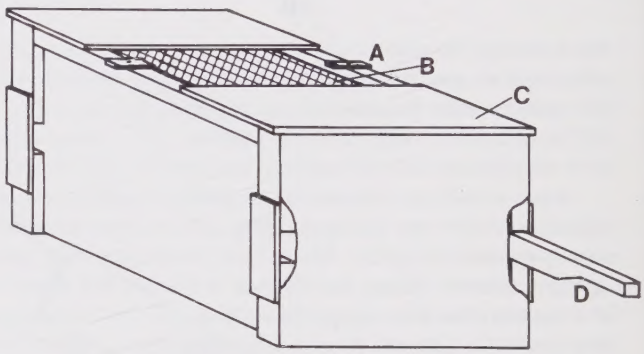


Figure 4.—A transport box with removable handles used to carry fur seal females and small males.

Boxes are built with 1 cm (3/8 in) plywood and 5 × 5 cm (2 × 2 in) lumber. Galvanized hardware cloth (0.6 cm mesh) is used for the top. Completely removable tops are more versatile than hinged tops. The plywood cross braces on the tops provide rigidity, safe handholds, and some visual screening of the animals from the box carriers. A simple, quick-acting latch mechanism is advantageous. For long journeys a raised false bottom of slats may be added to reduce contact of the animals with their own excrement. See illustration for construction details.

Adult Male Marking Box (Fig. 5)

This apparatus has been described in detail previously (Gentry and Johnson 1978); basic information about the device will be repeated here. The principle on which the box operates is physical immobilization through downward pressure. The top of the box can be lowered until the animal is pressed between the top and a false bottom. In that position small doors in the top provide access to various parts of the seal's body for tagging and marking. Also the top and false bottom with the seal sandwiched between can be hoisted as a unit for weighing.

[2]Daniel Costa, PRL, Scripps Institution of Oceanography, La Jolla, CA 92037, pers. commun. July 1981.

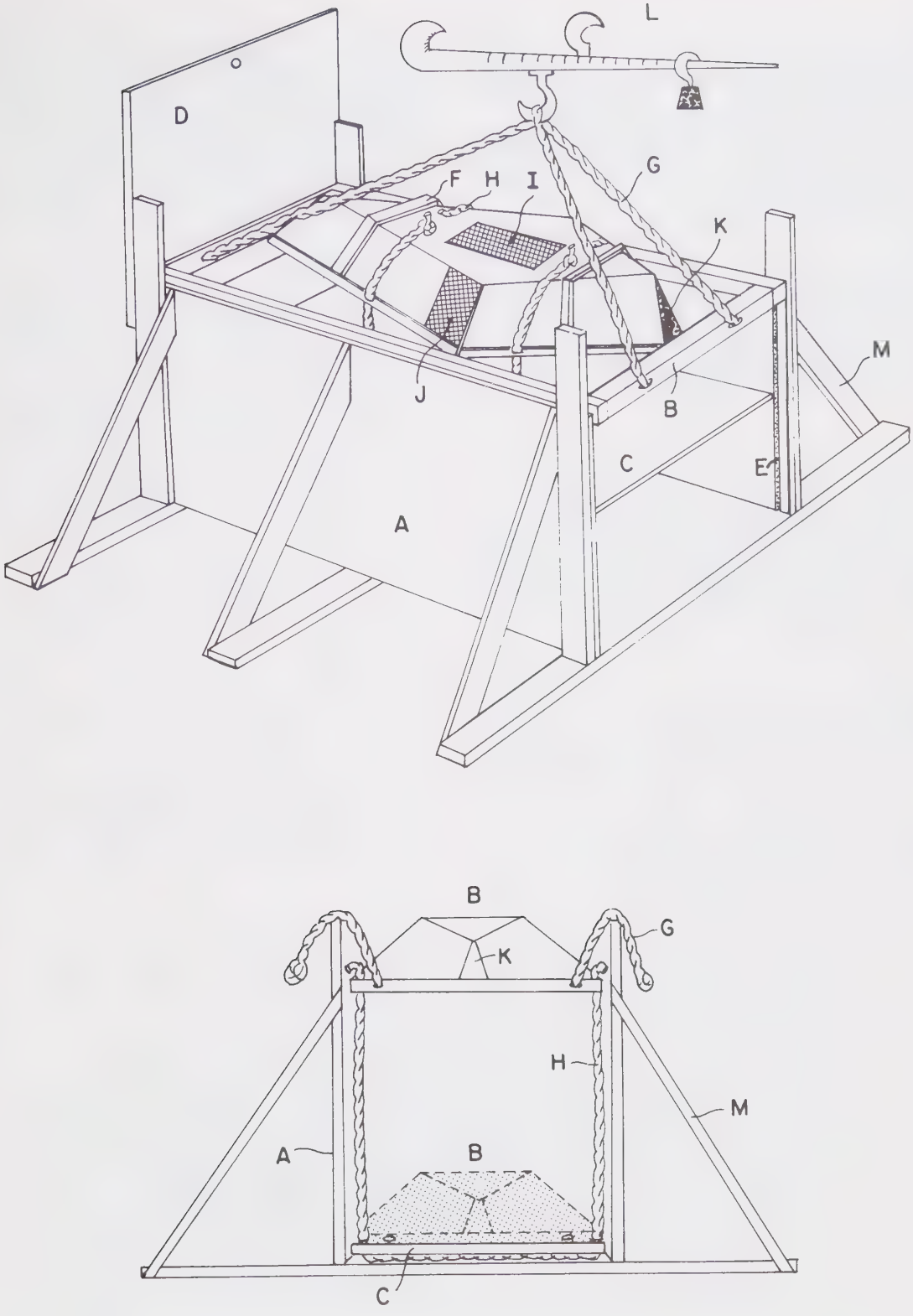


Figure 5.—A box with a specially shaped, moveable roof used to immobilize adult male fur seals using downward pressure. (Reprinted with permission of the Journal of Wildlife Management.)

The box measures 2.4 × 1.1 × 1.2 m high (96 × 42 × 48 in). Construction is of 2 cm (3/4 in) plywood, thoroughly braced on the outside. The box has vertically sliding doors in each end. The removable top and false bottom are small enough to slide easily up and down inside the box. The top has an overall oval dome shape (roughly the shape of a prone male seal). Six persons can carry the assembled box for short distances.

Noise Makers

Lightweight metal cans (2 to 5 gal fuel containers are appropriate) with a few loose rocks inside, make effective noise makers that are useful for driving large numbers of animals. These are shaken, or are rolled along the ground behind moving animals.

Marking

Some kinds of research require repeated observations on the individual animals within a season, or following known animals over periods of several years. A few animals (particularly older males) may be recognized repeatedly by characteristic scars or physical abnormalities. However, positive identification from one field season to the next, or among different observers requires unequivocal marking of individual animals.

Tags

Flipper tags have been the mainstay of the marking effort in the fur seal program. Although we may apply more than one type of mark to a given animal, the flipper tag serves as the ultimate identifier. Two types of tags are currently in use, both originally designed as cattle ear tags.

Monel tags are U shaped plates of monel metal, which, when closed, form a flattened oval ring through the animal's flipper. Once applied the tags measure approximately 0.9 cm wide by 4 cm long with numerals 0.6 cm high stamped into the metal. In good weather conditions these tags can be read with binoculars at distances up to 3 or 4 m, or with high-powered spotting telescopes (45 to 60×) up to 35 or 40 m away. Monel tags cause mortality. Their use on pups has been discontinued in favor of toe clipping (Johnson 1971).

Because the portion of the tag that penetrates the flipper is a flat blade (about 0.6 cm across), some injury may occur to the animals as the tags rotate. (We have no confident assessments of adult mortality which may be introduced by these tags, though we have seen many adult animals wearing the tags without apparent adverse physical effects.) Some improvement in the tag may be made by bending the portion that penetrates the flipper into a round post. This modification can be made with pliers, and the burred edges eased with a motor-driven wire wheel.

Jumbo Rototags are two-part plastic tags 1.9 cm by 4.4 cm. They come in various colors with 1.25 cm high black numerals heat-stamped on both the upper and lower parts. These tags can be read by eye at 3-5 m, and may be read up to 100 m away (occasionally farther) with spotting telescopes.

One advantage of the Rototag is that the portion which penetrates the flipper is a round post (about 0.5 cm in diameter) which allows the tag to spin freely on its axis without enlarging the hole in the flipper. We do not yet have estimates of loss rate for Rototags in fur seals. Some tags pull through the hole in the flipper, and a few tags break. Tags applied 5 yr ago still have discernable numbers though some more recently applied tags have faded. (Note: Rototags seem more adequate for fur seals than for other otariids (Hobbs and Russell 1979).) The tags are applied to the posterior (trailing) edge of the front flipper, about 3 cm forward of the edge. There are two sites for tag placement. One site is about 2 cm distal to the hairline across the flipper. This site contains veins and nerve tissue, so tagging should be done cautiously. In adult males the hairline site is too thick and fibrous to penetrate with Rototags, so either a monel tag can be used, or the animal can be tagged at the second site, between the 4th and 5th digits. The drawback of the latter site is that tags there are easily torn out, especially in large males.

Pelage Marks

In addition to tags we generally apply a larger, more visible mark to the pelage. Large (15-20 cm high) letter-number combinations may be painted on the animals with bleach. We use a catalytic mixture normally available only to beauticians called "Lady Clairol Ultra-Blue." This viscous liquid is painted on the dry or barely damp fur, and rubbed in. Within 1 to 3 d the dark guard hair is marked with a pale color ranging from a very bright beige to a fairly dark orange. If the mixture is rubbed into the fur carefully, and the animal does not go immediately into the water, the bleach can generally be expected to "take," though our results have been varied; rarely does the process fail to make a visible mark. A bleach mark considered "good" in one year can usually be seen the following year, though it will generally be faint and may not be readable. It is rare for bleach marks to last more than one winter. This means that for an animal to be followed for more than 1 yr (except by tags), it must be recaptured the following season and be remarked.

Marks may also be clipped in the guard hair with scissors. Clipping away the dark guard hair reveals the lighter underfur beneath, and leaves a readable mark without danger or injury to the animal. We have no assessment of thermal stress caused by this mark. Clipping marks is very slow work and the clipper's hands quickly tire. Clipped marks last perfectly well through one breeding season, but cannot be seen the following season. Marks clipped in the fur of pups early in the season will probably be completely grown in by mid- to late-October.

Two types of paint have been used with some success. Quick-drying highway or traffic paint adheres to the guard hair reasonably well, and if the animal does not go immediately into the water, the paint may stick for 2 to 3 wk. We use this paint to temporarily mark animals which we intend to capture and mark permanently at some later date. The paint can be applied with a sponge attached to the end of a bamboo pole. Identification by this method involves memorizing the irregular splotch marks of paint, or drawing sketches of the patterns on history cards for individual animals. The history cards should by updated frequently, since the paint gradually flecks off, and the size, shape, and pattern of the marks change with time.

Workers under contract to the National Marine Mammal Laboratory used a plastic resin naphtha-based paint marketed by Lenmar, Inc., which provided long-lasting (6 to 8 wk) marks in the pelage of fur seals (Griben 1979). Later examination of pelts from animals taken in the commercial harvest on St. Paul Island revealed abnormalities in both the guard hair and the underfur where paint was applied. We do not recommend the use of this naphtha-based paint on fur-bearing animals until more work is done to determine potential damaging effects.

We believe that branding with a hot iron is, on balance, the most humane way to mark seals permanently with a large mark suitable for behavioral research. It is preferable to slightly injure an animal once in its life by branding than to recapture it every year to refresh temporary marks, such as bleach or hair clipping provide. When executed carefully, skin-branding provides a good mark without serious injury. We have followed skin brands on some seals for 5 yr.

We use a hot iron in two ways. For temporary marks that last through one season, but that may not be readable in the following season, we use the iron to singe away the guard hair, leaving the lighter underfur exposed. Once the equipment is set up, this "hair-branding" technique is very fast for marking large numbers of animals. The cleanest marks result from branding wet animals because water prevents the hair around the brand area from flaming. If equipment is available this technique is preferable to hair clipping.

Skin-branding requires more caution and attention to detail than hair-branding. The very dense underfur absorbs large amounts of heat from the branding iron and, when burned, this fur may cake up to form a protective layer over the skin. We lightly singe the hair, then brush away the caked ash with a glove or a stout brush until the unburned underfur is visible. Then the still-hot iron is carefully reapplied to the same area, and hair is lightly singed again. Three or four applications of the iron may be necessary before the iron contacts the skin directly. A light, quick application of the iron to the skin is sufficient for scarring. Occasionally the branding iron may have to be reheated to its original cherry red color in order to penetrate to the skin. Burning the underfur also produces dense smoke that obscures the work area. Of 120 animals observed in 1978 which had been skin-branded with letter/number combinations in 1977, we saw no animals with inflamed wounds, though several of them had parts of the marks missing because the branding iron had not penetrated the underfur quite far enough.

It is important that the burning surface of the branding iron be curved in cross section, and have well-rounded edges. (We used round stock for fabricating our brands.) Sharp corners can burn quickly through the animal's skin to the flesh and leave long-lasting open wounds.

The location of pelage marks is important. Marks aligned over the animal's spine are the easiest to apply but can only be read from directly above, or if the animal lies on one side with its back directly to the observer. Such views are rare, so usually only part of the mark is seen. Marks on the flanks can be obscured by other animals. Two identical marks, one on each shoulder high enough that they almost touch at the mid-line of the back, are preferable. One mark or the other can usually be seen from any angle except when the animal lies on one side with its belly toward the observer. In this position its flipper tags can usually be read.

Whatever other marks are used, seals should also be given a spot (by clipping or branding) on the head. Guard hair should be removed in a circular patch 6-8 cm in diameter. In tightly packed groups of animals head marks are prominent and notify the observer to continue watching the animal until its mark or tag can be read. These marks have allowed us to identify a large number of animals that would never have been located by pelage marks or flipper tags alone. We now mark the heads of all animals we need to follow, regardless of what other types of marks or tags we may apply. Adult males are prominent enough without our applying head marks.

Harnesses

We use harnesses for attaching depth recording instruments to seals (Kooyman et al. 1976), for moving seals in captivity, and for securing special "chastity belts" to captive females during studies of estrus (Fig. 6). Harnesses are made of tubular nylon "rope" available in mountaineering stores. This rope lies flat like a double ribbon and is 2.5 cm wide. It is flexible and light, yet strong, it will not kink if rolled, and it is available in bright colors for easy visibility in the field. The harness has one strap around the neck small enough in diameter that it will not pass backward over the scapulae and front flippers, the point of greatest girth in otariids. It has a chest strap posterior to the front flippers which prevents the seal from backing out of the neck strap. The neck and chest straps are attached ventrally by two "belly" straps which prevent the harness from rotating around the seal's body, and by a dorsal midline "back" strap. Harnesses that carry instruments use a back strap made of stiff nylon belting material 5 cm wide. The neck and chest straps are adjusted to length by passing them through double "D" rings attached at the juncture of these

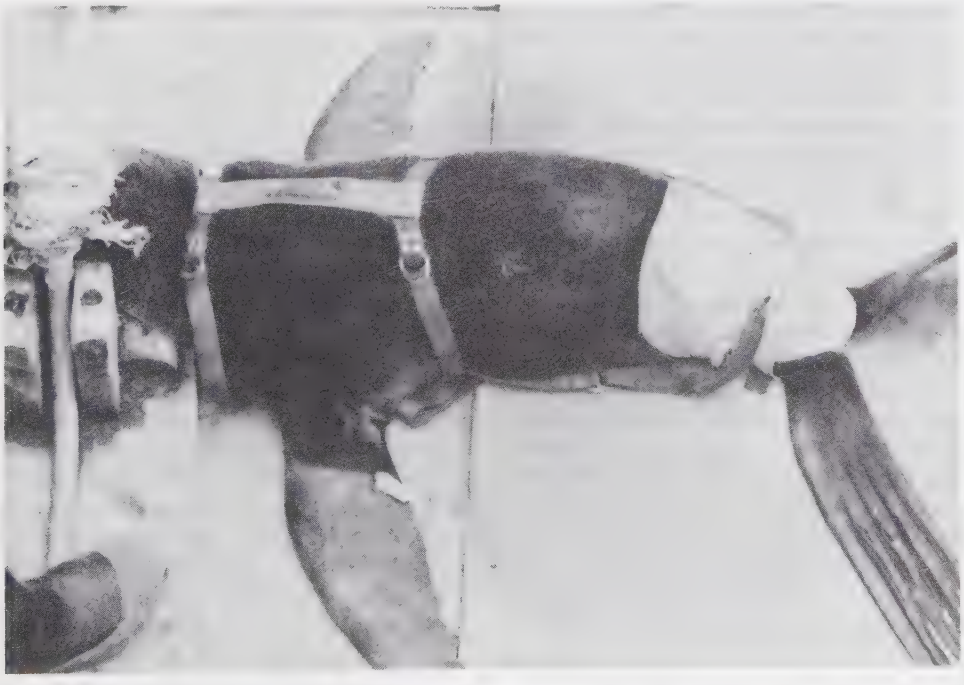


Figure 6.—A harness around the neck and chest of an adult female fur seal used to secure a "chastity belt" during experiments on estrus. The female is restrained by a hold-down bar.

straps with the back strap. The harness pieces are joined together with soft steel rivets so that if a released seal fails to return these rivets will soon rust, allowing the harness to fall apart.

Harness sizes and proportions vary, depending on the age and sex of the seal. The dimensions of a harness for a juvenile male seal weighing 65 kg (about 145 lb) are given in Figure 7. Note that the belly straps are longer than the back strap to accommodate the large chest muscles when the seal sits upright. No such accommodation is necessary in harnesses for females.

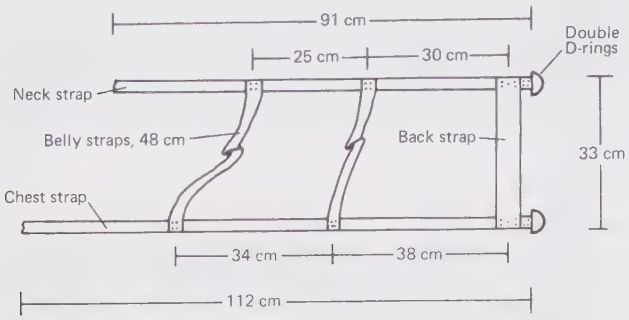


Figure 7.—The dimensions of a nylon harness used to attach a time-depth recorder to a 65 kg juvenile male fur seal.

CAPTURE TECHNIQUES

Adult Males

Teamwork is more important in capturing adult males than in any other kind of capture. One person should be responsible for determining which animals are to be captured, what efforts are needed to keep the captures running smoothly, and what steps are necessary to alleviate problems that arise (which rope to tighten, how to move an animal into a better position, what direction to pull, who on the work crew should move to another rope, etc.). The crew should be enthusiastic for the work to be done and have good rapport with the leader. Before marking begins the leader should demonstrate how to move around the animals, how to stop a charging male with a bamboo pole, and generally what to expect. He should stress the need for concerted group action, and the need for decisive individual action when someone is endangered. He should also stress that while there is no shame in running from a charging adult male fur seal, the worker who runs at the seal's first snort may abandon someone in a dangerous position and undermine the confidence of the rest of the crew. The leader must anticipate that some workers, when excitement is high, or when there has nearly been an accident, tend to vent their emotions through excessive roughness to the animals. Such persons are not allowed to work on our projects. In addition, we forewarn our workers that they may respond to stress in these ways, and that such actions are inappropriate and unacceptable.

Terrain is important to success in capturing adult territorial males. Most of our 155 successful captures have been made on a broad flat area measuring approximately 40 m by 100 m with a slight uphill slope at one end. The surface is hard-packed dirt or bedrock littered with fist- to man-size rocks. At another site, attempts to drag the animals up a narrow sloping beach of large boulders proved unsuccessful. The animals were able to wedge themselves behind the large rocks, and no amount of pulling would move them up the slope.

Marking may begin soon after males start arriving in May, and continue until the animals are too numerous to permit safe work, or until females begin arriving on the site. Optimum weather conditions for marking are heavy overcast, no precipitation, and a moderate wind. Rain makes both the ground and the animals slippery and treacherous, and bleach marks often do not "take" on wet fur. Work may be done on sunny days or warm days with no wind, but only with considerable caution: the animals are easily overheated.

The capture consists of getting two ropes (or lassoes) around the animal, and quickly dragging it to the marking box. Typical ropes are 1 cm (3/8 in) hemp 12-15 m long. At this time of year male fur seals are probably at their peak weight, and their necks are larger in diameter than their heads. A noose around the neck of an animal will merely slip off when the animal offers any resistance to being pulled. Nooses must go around the neck of the animal and behind one front flipper. When the two ropes are correctly applied each should pass over the animal's back, one going behind each front flipper, and crossing each other at the animal's chest (like bandoliers) (Fig.8) with the two ropes emerging from the loops close together at or below chest level.

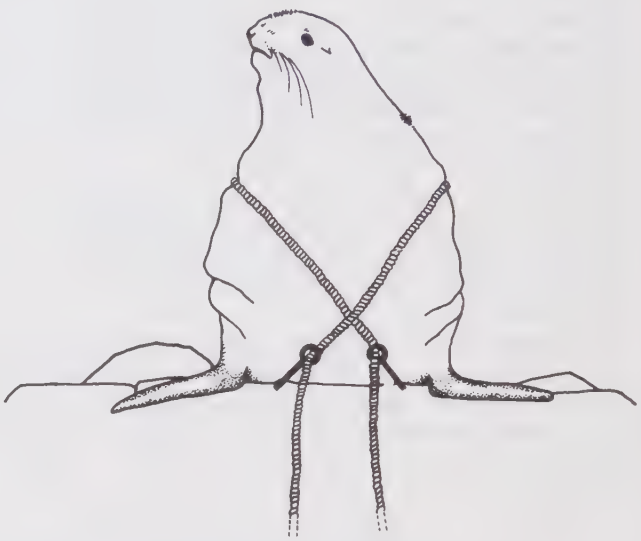


Figure 8.—An adult male fur seal showing the proper placement of two ropes across the chest used to drag the animal into a box for marking.

The animal should be approached by as few people as possible: one person manipulates the noose, one maintains tension on the rope, and one person assists in maneuvering the animal. A fourth person may stand ready with a bamboo pole a meter or so behind the working crew to provide assistance if needed. This small number of people seems to cause less disturbance, and the animals remain quieter and easier to work with than with larger crews. The lasso is hung on an 8 cm diameter hook at the end of a 4-5 m bamboo pole. The hook can be tightly strapped onto the pole with fiber tape about 5 cm back from the tip in the fashion of a boat hook. The lasso is not thrown because the flying rope frequently alarms the animal. The rope loop is dropped over the animal's head, and then arranged with the hook in such a position that the seal may step through it with one front flipper. By staring or approaching to within 2-3 m (ready to jump back quickly) one person can induce the seal to step forward into the loop, or to make a short charge or boundary display. At this instant the person controlling the end of the rope takes up the slack and pulls the noose tight in position across the seal's chest and behind one flipper. Some experimenting will show how best to position the rope to achieve this effect, and what sorts of noises or motions work best to stimulate the animals to move forward.

While the two ropes are being positioned it is important that the animal remain facing the marking crew and stand its ground. For this reason late May and early June are the best times for marking adult males. The animals are still sparsely distributed, and their territorial defense is strong. This is the time of year when males are most likely to continually face toward approaching humans and hold their ground rather than turning and running; they are most likely to make the lunges or boundary displays necessary for getting the rope loop behind the front flipper. Only when the animal is facing the direction it is being pulled can it be held successfully in the ropes. When the seal turns away the ropes are no longer hooked behind the front flippers, and the nooses simply slide back along the seal's tapering body.

To aid in positioning the rope the third member of the front rank working crew can stimulate the animal to move by judicious use of a bamboo pole. A light touch, or mild poke to the animal's hindquarters will generally cause it to move away from the stimulus; touching a front flipper with the pole will induce the seal to retract the flipper. These two tendencies are used appropriately to position the animal as desired. When inducing the seal to step through the lasso care must be taken to avoid touching the front flipper or the seal will retract it away from the rope loop and the procedure must be started anew. With the rope in place, and a worker maintaining tension on it, a fourth member may join the front party with the second rope, which is positioned similarly to the first.

Once the two ropes are properly positioned on the animal, other members of the work crew who have stayed 10-20 m back from the front rank may come forward and lay hold of the two ropes. The best procedure is for the six- to eight-person team to drag the animal to the box quickly (at a run if possible). Moving the seal slowly allows it to brace itself against rocks, to resist the movement, or slow movement may allow the animal to turn away and slip out of the nooses.

As the workers drag the seal toward the marking box, one of the two ropes is passed through the box and will be used to pull the animal into the box. As each worker on this pulling rope approaches the box, he releases the rope, runs around the outside of the box, and picks up the rope again on the other end. The second rope can be used to help control the path of the animal's slide toward the box. As the animal gets close to the box, only one or two people will be needed on this controlling rope; others may move to the pulling rope to help with the strenuous task of getting the animal into the box.

Just as the seal is reaching the box it is helpful to have one person leave the positioning rope, pick up a 2-3 m pole, and push the animal from the back side. The seal will offer considerable resistance to entering the box, hooking its flippers on the side, and forcing its head against the sides and top of the opening. The person with the pole can help by defeating the animal's holds on the box and allowing it to be dragged inside by the other workers. This person also has the clearest view of the seal's body entering the box, and is in the best position to shout the order to close the box doors.

One worker is designated from the beginning to be in charge of operating the doors to the box. This is an appropriate job for someone who is not a strong puller, or who is uncomfortable working close to the animals. As soon as the ropes are in position on the animal and the crew is ready to begin pulling, this person should be alerted to take position standing astride the top of the marking box. Once the seal is inside the box, the doors are dropped. The first door to be dropped is the one toward which the seal is being pulled (between the seal and the workers pulling it). Tension on the rope can be maintained by the pullers (holding the animal inside the box) while the rear door is dropped and the animal is contained.

An attentive person with a bamboo pole can stop all but the most concerted charge by a male fur seal. The most successful technique is a sharp jab or push with the end of the pole to the animal's chest or throat. A balance must be struck between very hard blows and accurate ones. The harder the pole is pushed, the less accurately it can be controlled. If a jab misses the seal and the animal moves closer, shorten the pole or step back and take another jab. Banging the charging seal on top of the head or batting it from the side will produce almost no effect whatever. If the animal is just beginning to move, a sharp blow to the side of the head may stop it, but this is risky because of the danger of destroying an eye or breaking a tooth. (The loss or breakage of a canine is a very harmful event for a territorial fur seal.) An animal that is not charging, but is generally too close to the work area or otherwise in the way, may be distracted by dangling the end of a pole just out of reach in front of and above its face. Soviet scientists move stationary males by lightly tapping them on the head with a bamboo pole that has been intentionally split into a dozen or more "ribbons" at the tip. These ribbons make noise but do not injure the seal.[3] Except very early or very late in the season it is nearly impossible to drive a single adult male out of its territory, even with the concerted efforts of several people with bamboo poles. Workers confronting a seal should stay familiar with who and what is behind them in the event that they may not be able to stop the charge, and must either run backward or turn and run. Special efforts should be made to avoid falling down on the rookery.

Subadult Males

Unlike the capture of adult males and adult females, which takes place on an individual basis, subadult males (2 to 5 yr old) are rounded up in small groups and held temporarily while individuals are pulled out and marked. These roundups usually occur on hauling out grounds adjacent to breeding areas. The most important factor in successful roundup, capture, and marking of subadult males is weather. These animals are very easily heat stressed. Careful attention must be paid to weather conditions and to physiological symptoms of the animals. Ideal weather conditions for working with subadult males are cool temperatures ($< 10°C$), moderate winds, and overcast skies or light misting rain.

A roundup begins by two or more workers moving unnoticed into a position between the seals and the water. This may involve taking a long roundabout route, or some crawling on the ground to maintain a low profile. Remaining unseen during this first step is critical. Once in position below the particular group that is desired, the workers stand up, raise their arms or protective poles, and shout, whistle, or rattle noise makers. Once the seals begin to move inland, very little effort is required to keep them moving. In fact, the most attention must be paid to keeping the animals from moving too far or too fast. Some experimentation will show how much distance must be kept between the seals and the "herders" to move the animals an appropriate amount with the least amount of agitation.

Slow movement of the animals from one location to another cannot be overemphasized. Body heat builds quickly and is lost very slowly. The following symptoms indicate overheating: captive animals that lie prone rather than sitting erect, excessive rear flipper waving, animals which tilt their heads far back and pant with a rattle in their throats, animals which can move only a meter or so without falling prone to rest.

Once the animals are in position for holding and marking, minimal herding actions are required. One person or two can manage a small group (30 animals or fewer) without excessive agitation of the seals. A good strategy is to squat or kneel 5-10 m from the group and stand up or move into position to cut off their movements only when necessary. Cutting the animals off with the least disturbance involves mak-

[3]V. A. Vladimirov, VNIRO, Moscow, U.S.S.R., pers. commun. July 1981.

ing a wide circle around the group, to avoid causing them to run harder.

Portable fence sections can be used to erect a temporary open corral. Four or five partitions 1.25 m (4 ft) high and 2.5 m (8 ft) long are framed with standard construction lumber and covered with heavy-duty wire fencing material. An extra horizontal framing member about 0.5 m high receives the major stress of seals pushing against the fence. Corral sections are arranged with the wire fencing material to the inside to prevent animals from climbing on the horizontal brace. The fence sections are erected in an open U shape and tied together with rope. If marking or tagging operations take place about 5 m in front of the open end of the corral, the animals will stay inside with little attention from the workers and little agitation among the seals.

Seals held in close pods either by a corral or by a herder may lose body heat more slowly than normal. Close contact of their bodies and occasional crawling on top of one another can inhibit heat loss. For this reason the condition of the seals must be continually monitored even after they are enclosed and motionless.

Once the seals are rounded up and moved some distance inland, they may be captured individually for marking or tagging. The wire fence corral proves most effective for these individual captures, because a single worker can approach the group of seals and not require the assistance of two or more herders to prevent the group from moving away. Chokers 2.5 m long are used to snare individuals and pull them out of the group. (See section describing capture of adult females for choker techniques.)

Subadult male seals can be immobilized safely with a restraint bar. Various techniques for getting the animal into the restraint bar may be developed according to how many workers are present and how large the animals are. Although two people can manage the task, three are preferred. With two persons, one drags the seal using a choker, and the second grasps the seal's rear flippers. The seal is dragged sideways to the restraint bar. There the individual handling the choker holds the animal's head down with the neck across the yoke of the base plank while the second person releases the hind flippers and swings the bar into position.

In closing the bar, care must be taken to keep arms and elbows out of reach of the seal, and closure must be made quickly but judiciously to prevent the animal from biting the descending metal bar. This type of restraint device may have fabric padding wrapped around the metal bar at the U bend. This padding can prevent injury to the seal should it bite the bar, and also allows some adjustment in the size of the opening. With three persons available for restraining the animal, one may handle the choker, one holds the animal's rear flippers, and the third person can manipulate the restraint bar.

Even while in a restraint bar, seals can show considerable strength in lifting themselves off the ground with their front flippers. An animal struggling in the bar can best be restrained and quieted by pulling its front flippers back and folding them under the body. This can easily be accomplished by a person straddling the seal in the kneeling position. This straddled position is convenient for applying tags and marks, clipping heads, installing harnesses, or simply restraining the animal until it stops struggling. Even while restrained in the bar the animal has a surprising reach with its neck. Be watchful of arms and elbows in the vicinity.

There is some danger of asphyxiating an animal in the restraint bar. With careful observation however, this danger can be reduced to a minimum. A number of symptoms give advance indication that an animal is suffering undue stress: 1) breath rate—it is sometimes difficult to determine whether the animal is voluntarily holding its breath, or is being prevented from breathing by the restraint bar or choker. With a finger sharply jab the seal in the ribs; breathing will resume if the breathhold is voluntary. 2) Breath sounds—normal breathing may be quite noisy even when the animal is getting adequate air, and the inspiration may be short. However, if the inspiration is very labored and terminated by the jaws audibly snapping shut, the animal's trachea is probably compressed, and the pressure on the restraint bar should be eased. 3) Tongue color—the tongue is a fast indicator of the animal's condition. If the tongue begins to turn blue, the animal is short of air; the bar should be eased and the animal encouraged to breathe deeply for several seconds. 4) Eyelid twitching—rapid twitching of the eyelid is another indication of interrupted air supply. All four of these symptoms are indicative of more serious problems to follow within a few seconds if the animal's situation is not changed quickly. 5) Convulsions—violent convulsive quivering immediately precedes unconsciousness. When an animal begins to convulse, pressure on the bar must be removed immediately. (For this reason it is important to keep the choker loosely around the animal's neck even when it is being restrained in the bar.) With the bar released (and one person standing by ready to tighten the choker) a sharp blow with the fist or heel of the hand high on the animal's back, or a vigorous shake of the animal's hind flippers is adequate to bring the animal back to consciousness and restart the breathing. Speed and decisive action are essential if the animal is to be spared.

The person handling the restraint bar has the best visibility and should carry the responsibility for observing the animal's condition, but all workers should be aware of the animal and watch for symptoms of stress. When a large number of animals is to be marked, handling the restraint bar can be a tedious job, yet it requires a high level of attentiveness. Safety of the animal and the persons working around it are at stake. This job should be rotated among workers at the site, or the one person with the job should be given considerable encouragement to remain alert.

Peripheral Males

Male fur seals approaching adult size (5-7 yr old, 100-160 kg) can be caught and marked using a hoop net. They are not immobilized, but since their vision is restricted by the specially constructed net, they struggle relatively little. Males of this size can be found moving about on the periphery of the rookery (hence their name); they are also called "idle bulls." These males are beginning to acquire the final adult "shape," but are not as broad across the chest as are fully adult males.

Capturing peripheral males is very active work because they are not yet defending a territory and, hence, will not stand their ground. Rather, they tend to run into the nearest rookery, or through a rookery to reach the water, which can cause considerable disturbance. Prior to a capture attempt, the animals should be driven inland, either individually or in small groups, some distance away from the rookery edge. This allows some operating room for the captures and reduces the disturbance to the rookery caused by humans moving about. It is also easier to control the movements of animals once they are some distance inland. A peripheral male making a vigorous effort to escape into a rookery or into the water is virtually impossible to stop with a bamboo pole.

This type of capture requires only a hoop net 0.75 m in diameter and 2 m deep (described above), three or four workers, and at least two stout bamboo poles 3-4 m long. The longer poles for capturing territorial males are rather cumbersome for cutting out one of these large animals from a group. Whatever marking or tagging equipment is selected for this animal should be carried in a bag or bucket because the final location where the animal will be immobilized is difficult to predict.

Two persons cut out an appropriate male from the group that has been driven away from the water, or cut off a single individual from its escape route. A third person handles the net. In some cases a fourth person may be required to control a pod of large animals that has been driven inland to prevent them from scattering while the individual capture is taking place.

In this technique the ultimate objective is to get the hoop over the animal's head and all the way to the ground with the animal's head inside the bag in the deep end of the net and then to have the animal step over the hoop and into the net with at least one of its front flippers. Since a running animal will be less aware of the net in the air over its head and will be less likely to bite the hoop as it descends, it is best to induce the animal to run away from the net handler before the capture attempt. A running animal can sometimes be properly netted in a single stroke. Avoid netting stationary animals. Males isolated at a safe working distance from other seals will remain stationary, facing their captors, unless goaded into running. Stationary animals can bite the hoop and break their canine teeth. They can also shake their head and neck vigorously to dislodge the hoop. Stationary males can be made to run by a series of jabs to the ribs or flanks with a pole.

Once the hoop is over the animal's head a second effort is frequently required to drive the animal entirely into the net and complete the capture. For this step of getting the animal into the net, the net handler should be behind the animal. Maintaining this position may require running around the animal while holding onto the handle of the hoop since netted seals tend to spin. The other two members of the party must try to stay out of the net handler's way in this exercise. A bamboo pole can be used to lift the net and bag into the air over the head of the animal while the hoop is forced to the ground so that the bag drops over the seal's head.

One final step is important to prevent the seal from backing out of the net. The animal should step forward over the hoop, so that it is standing with at least one and preferably both flippers on the metal hoop, or on the net outside the hoop. Once this is accomplished the animal will be holding the net stationary with its own weight. If the seal will not voluntarily step forward, have one worker grasp both rear flippers and pull backward (out of the net). Seals resist this pull by obligingly stepping forward. To secure the net, the rear flippers are tucked inside the hoop, and the net handler stands atop the junction of the loop and the handle.

Although the animal will be noticeable quieter with its head in the bag, the net allows considerable freedom of movement of the seal's head and upper body. Precautions must be taken to prevent workers from being bitten through the bag. Two persons work on opposite sides of the animal from the rear angle. One reaches across the back of the animal, forces a bamboo pole into the ground just forward of the front flipper, and holds it vertically between the seal's head and the third person, who attaches tags to the front flipper (see Fig. 9). It is also possible to help control the animal by grasping the mesh of the net low down on the animal's back and pulling the seal off balance sideways.

Tags may be applied through the mesh of the net. The person applying the tag must be conscious of maintaining good balance, and of not becoming entangled in the net, since netted animals can still lunge dangerously. It is easy to become involved in the concentration of getting tagging pliers into the proper position or to become frustrated with a difficult animal. This can lead to dangerous situations.

The animal is released by lifting the net up and moving it forward, allowing the seal to back out. If the animal becomes tangled in the net during capture the purse string at the end of the net can be cut to release the animal through the deep end of the net. The animals are generally disoriented for several seconds after release. Nevertheless, one person with a bamboo pole should stand by to protect the net handler. Avoid snaring the tags in the mesh, since they may be pulled out of the flippers as the net is being removed.

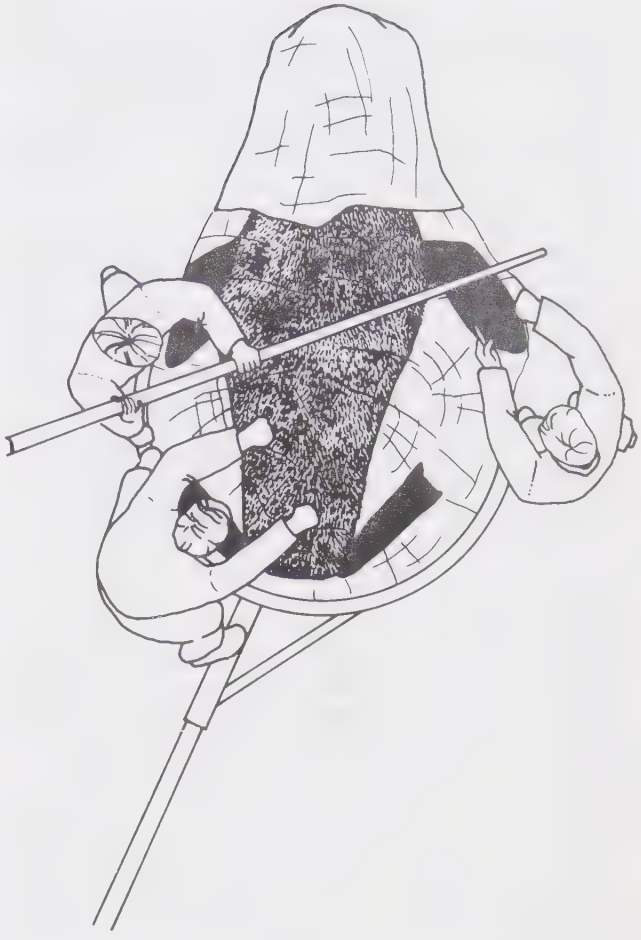


Figure 9.—A method of capturing male fur seals weighing up to 160 kg using a hoop net. The seal's vision is obscured by a bag sewn into the deep end of the net. One worker stands on the handle of the net and keeps the seal off balance by pulling on the net. A second person holds a pole between the seal's head and front flipper to protect a third worker, here applying a tag, from being bitten.

Adult Females

Each capture situation with females is unique, depending on the time of year, type and number of females desired, the stage of the reproductive cycle, and the amount of disturbance the worker is willing to create. The procedures described here have evolved over several years of catching animals. Although certain of the precautions should not be violated, successful captures frequently depend on the worker's ability to be inventive or to make fast decisions in the midst of the situation.

1) Noose captures.—At the right time of year adult females can be captured individually with relatively little disturbance to the rookery. The basic technique consists of locating and ensnaring a newborn pup whose mother is identifiable, holding the pup until the mother can be ensnared with a long choker, and then pulling the two out of the rookery.

Captures employing this technique have been made in the Pribilof Islands from about 20 June to 15 July. Later captures are possible, but after mid-July new births are very infrequent and do not commonly occur on the inland edges of the rookery as they do earlier in the season. Mothers with newborn pups are preferable for several reasons: 1) the mother/pup bond appears to be strongest 1 to 3 d after parturition. In this period mothers are least likely to run to the water as humans approach, or to abandon their pups upon being released after the capture. 2) Strong pup attachments occur almost simultaneously among the female population because of close synchrony in the timing of births. Therefore the entire rookery is less sensitive to human presence when newborns are available. 3) Newborn pups offer little resistance to capture. 4) Mother and newborn pup are usually physically close to each other so that pairs are easy to recognize. 5) The date of parturition is known if needed.

Equipment for this type of capture consists of one bamboo pole 3 to 4 m long for defense against males, one 5 m long choker of fir for the female, and one 5 m long choker of bamboo and light cord for the pup. Transport boxes, hold-down bars, or marking equipment are used as appropriate, but these are left at some distance back from the edge of the rookery.

The keys to a successful approach are moving slowly and maintaining a low profile. Voices must be kept low, and equipment not allowed to bang or rattle on the rocks. Keep all equipment low to the ground or disturbances will result. Only two persons are needed for this type of capture, and they should approach the back edge of the rookery carefully. Within 10 m of the closest females they sit down and continue moving on hands and feet (spider fashion), sitting between moves. If there are many threatening males, move on hands and knees, or "duck-walk" in preparation for defense against males.

Patience during the approach phase of the capture is often rewarding. We typically spend more time approaching and waiting for the female to make a favorable move than at any other part of the capture routine. A few minutes spent in an uncomfortable position on the rocks surrounded by large males causes apprehension, but waiting is preferable to hurrying the capture, or making a frantic lunge which can defeat the entire effort or cause a major disturbance.

Selecting the pair to be captured is more difficult than it sounds. New pups are best identified by the condition of the placenta; it will remain bright red and bloody for 24 h. The umbilicus remains pink and wet-looking for 48 h. Mere presence of a placenta does not indicate new births since a dry, black placenta may be dragged about for 6 or 7 d. Age is more difficult to identify in the rain since the umbilicus remains clean and wet looking longer than on a dry rookery. Sometimes the pup must be noosed and turned onto its back with a choker before the condition of the umbilicus can be seen. The mother's reluctance to leave a pup is a good but imperfect indicator that the pup is new. Some solicitous females remain with their pups for 6 or 7 d after birth. Regardless of the age of the pup, do not attempt to capture females that abandon their pups and flee; fleeing females cause a great disturbance. Once the pair is selected for capture the workers should keep close watch on both members of the pair to avoid capturing the wrong partners.

The pup should be noosed first before the mother moves it. The lightweight noose is dropped over the pup's head and the pole is rotated until the rope is tight. Whenever a choker is used, raise it in the air just high enough to clear the animal's head; a waving choker alarms all the animals. Do not stand up while placing the choker; place it from a sitting, kneeling, or squatting position. Always move the choker slowly, and do not make rapid thrusts at an escaping animal. When the pup choker is loosely in place the pole may be placed on the ground and the pup ignored until the mother is noosed.

The technique used to noose the mother depends on her behavioral tendencies. The easiest case is when the female is relatively fearless and is on the edge of the group of animals. In this situation let the choker lie on the ground beside the female. When she turns her head away from the choker, lift it just enough to drop the loop over her head from behind and tighten by twisting the choker pole. The rope should not be allowed to wrap around the pole as it is twisted, but should form a twist off the end of the pole just under the chin (Fig. 10). Since the seal's head is narrower than its neck the loop must be twisted very tight—so tight that a fold of fur is caught in the twisted rope. Work quickly but without sudden jerks that alarm the female. Give the choker a trial pull to observe whether it is tight enough.

Figure 10.—Illustration showing the placement of a choker (A) too high on the neck, (B) correctly, and (C) too low. The same placement is appropriate for both juvenile males (shown here) and for females.

If the female is wary and ducks away from being noosed other measures are required. First, slowly draw the pup away from the female a meter or so. If the pup is moved too far from the mother she may not come out of the group to retrieve it. If the pup is not moved far enough she may seize it in her teeth and start back with it before the noose can be placed over her head. This can result in an unwanted tug-of-war with the pup in the center. If this occurs allow as much slack on the choker as possible and induce the female to release her hold on the pup. As an alternative to drawing the pup out, agitate it by moving it forward and back, or side to side using the choker. Moving the pup, or drawing it out keeps the female's attention on the pup and away from the workers or the choker. Drawing the female out, if it works, also reduces the disturbance to other females.

If a female is wary of the choker and will not follow her pup out of the group, move the pup close to the mother and lay the open loop of the female's choker on the pup's back. Then when the female touches the pup's back with her nose, which they often do, lift the loop over her head.

Once the female is caught in the noose she should be removed with all possible speed. Both workers stand for the first time and, with a hard pull that brings the female forward onto her belly, they run several meters. Running bent over causes less disturbance. When the female is 4 to 5 m from the group one worker drops behind and grasps one or both rear flippers. The female may then be half dragged, half carried either with the workers in tandem or side by side. Running removes the female from the male's presence as quickly as possible, shortens the time the female lacks air, and prevents the female from resisting being moved. The lead worker should be aware that this is simultaneously the moment of greatest stress and the moment when the most important decisions are to be made; he should try to remain calm despite the exertion.

While dragging the female carefully watch her condition. If the noose is tight enough to prevent her backing out it may also close her trachea. If the female begins to convulse release the rear flippers and loosen the choker immediately. There is little danger of the animal escaping during this procedure. The symptoms and response to asphyxia were given in the section on handling subadult males. Remove the female from the sight of other females as quickly as possible.

After the female is immobilized in the restraint bar, or placed in the transport cage a single worker returns to retrieve the pup. Special attention must be given to moving pups with attached placentas. These animals must be lifted carefully over rocks or sharp obstructions; even a moderate pull on an attached placenta may eviscerate the pup. To carry a pup with an attached placenta grasp the umbilicus close to the placenta in the same hand that holds the rear flippers. If it is decided to remove the placenta tie off the umbilicus with a piece of string a few centimeters from the belly and cut distal to the string to prevent bleeding.

To be certain that the correct pup has been captured for a given female place the two captives close together. A vigorous vocal exchange will indicate that the two are a pair; the female will repeatedly nip any pup but her own. Occasionally a female will even bite her own pup inside the transport cage. Remove these pups to prevent injury.

Pregnant females too can be captured by noose but these are the most difficult and dangerous of all captures. Pregnant females usually flee at the first sight of a choker unless the approach is made from the water's edge working uphill. From that position they are almost as easy to noose as any other female. But working between breeding seals and the water leaves no room to maneuver away from charging males, and the footing in tidepools is difficult. Also, an extra helper is needed to watch for new males arriving from sea during the disturbance. Pregnant females, being heavy, cannot be dragged away from the males as quickly as nonpregnant ones, and may be bitten as they are pulled out. These captures should not be attempted unless the acquisition of pregnant animals is mandatory; when captives are required we recommend post parturient females. These captures should never be attempted by inexperienced workers.

The problem of greatest concern in capturing females, especially in captures with a noose, is the adult territorial males on the rookery. The greatest danger from these animals is misreading their signals or reacting slowly to their threats. One must not be intimidated by their appearance or by the mental image created by the name "bull seal." These animals have many behavioral characteristics that can be employed against them by a clever worker. Admittedly there are a few males whose aggressiveness and tenacity cannot be dealt with using any combination of tricks. The wise worker identifies these seals and simply works elsewhere.

Adult males attend to the workers as soon as they are visible on the rookery. Their vocalizations alert all animals to the workers' presence. As soon as the workers have crawled up to the edge of the male's territory the seal will charge. Usually the first charge is the longest and most determined. From the squat position deliver a powerful jab to the seal's chest and throat area using the short bamboo pole. Usually one or two jabs will stop the charge. The second worker with another pole should be positioned behind the first so that if the charge does not stop, the lead worker can run while being protected. Deliver as few jabs as necessary since swift motions disturb the females. Do not stare directly at territorial males since this induces them to charge. Instead face obliquely and glance at them occasionally. Lying prone on the ground also reduces the frequency of male charges, although it heightens the sense of vulnerability. After two or three charges the male will usually rejoin the females. A perceptive worker can anticipate each charge since males usually draw a deep breath while looking obliquely at their target just before they rush. If the workers make daily appearances on the rookery to capture females the initial charges will become fewer and less determined.

Males most often interfere with the capture by blocking the target female from being noosed or removed. With persistent males, tap them lightly on the rear flippers or in the ano-genital area, or tap them lightly in the ribs or on top of the head with a choker. Some males will avoid these mild irritations by moving away. Frequently an overly attentive male (or an aggressive one) can be diverted by tossing over its head small rocks which fall into the rocks on the opposite side of the female group. The small clatter of these stones will mildly disturb the females, and the male may rush to block their exit. The male's attendance on the opposite side of the female group aids captures by keeping the females stationary. Bothersome males can also be diverted by arousing adjacent males. Pebbles cast at neighboring males causes them to vocalize, herd their females, or give a boundary display at the subject male which effectively reduces attention to the workers.

While the noosed female is being dragged from the rookery, the male may chase her for 10 m or more. The male's chase is the main reason the female should be removed while running. If the male catches the female he may deliver a wound to her back, or may seize her in his teeth so that a tug-of-war ensues. The best tactic is to stop moving the female just before the male reaches her. Use the short bamboo pole to drive off the male if possible. Do not pull on the female being held by a male; allow the male to carry her back to the group and try to divert the male as above.

Other males may approach from the sides or from the back if the capture has taken a long time. Use a third worker to keep the path of approach open at all times if there are so many males that such closure is likely. After the female has been removed from the rookery proper the danger from males is not over. Peripheral males will be attracted from 50 m or more by the sight of a female above the rookery. These males show more attentiveness to the female than aggressiveness toward humans. Although they can be driven away easily the danger from these animals should not be minimized

2) Net captures.—If females are to be captured later than the last week of July a hoop net must be used since at this time of year females will not remain stationary long enough to noose them. Catching with a net causes more disturbance than catching with a noose, and since an animal is relatively less restrained with a net than with a noose, the animal is more dangerous to the workers. However, this type of capture requires less experience to succeed than do other types of captures.

The equipment necessary for this type of capture is a hoop net 0.75 m in diameter, having a 1.5 m deep net with 10 cm mesh, and a handle 4 m long made of aluminum tubing. The hoop should be wrapped with cloth or rubber to reduce noise when hitting rocks. Captures using a net depend on stalking a sleeping seal until the workers are within 5 to 6 m, and then making a sudden, short dash to the animal.

The workers must approach slowly, remain hidden at all times, and make no noise. The approach phase of such a capture is often more prolonged than with a noose capture. Do not try to outrun seals over large boulders while holding a net. Furthermore, stalk a specific seal; do not alarm a group hoping to make an instant choice during the chase. If the target seal is in the center of a group, the seals at the edge of the group can be moved out of the way by tossing pebbles onto the rocks near them and making sudden hand and arm movements that only they can see.

Try to net from directly behind a fleeing seal, placing the hoop over the head and neck so that the seal steps over the front edge of the hoop into the net. Then lay the hoop flat on the ground and stand on the ring. The head can be held immobile with a hold-down fork, or by grasping large folds of skin just behind each ear using bare hands. To transfer a netted seal to a cage or restraint bar, first place a choker on the seal while it is still under the net. Adult males are not a factor in this type of capture since they either are not present or are not territorial after 1 August. No bamboo poles are needed for defense against males here.

3) Mass captures.—It is possible to capture 50 to 100 females in a group after the first of August. These captures obviously cause great disturbance to the rookery, so they must be well justified. The principle is that a group of females and pups is cut off from escape to the sea by workers holding moveable fences. By advancing the fences away from the water the seals can be removed from the rookery to flat ground where the fences can be formed into a corral. From the corral females can be handled individually with a choker. We have made mass captures while adult males are on territory. However, this procedure is exceedingly dangerous and should not be attempted by inexperienced handlers.

At least six workers holding three sections of fence between them are required. These fence sections may be similar to those described for use with subadult males. The workers move the fences as close to the back of the rookery as possible without detection. Two teams station themselves together at least 25 m from the third single team. At a signal, the teams dash forward holding the fence between themselves and the seals and attempt to form a U-shaped enclosure on the seaward side of the seals with the open arms of the U facing inland. Surprise and speed are essential. The females will quickly collect against this fence in a pile and must be forced to move away from the water by prodding them through the fence with bamboo poles, by shaking noise makers, and by physically pushing them with the fence. Females in a mass are very difficult to drive in a desired direction. However, it is imperative that they be moved immediately; otherwise, pups are likely to be killed by suffocation. Once females are moving they must not be allowed to stop because they are difficult to start again. When the animals are in the desired location for further handling a fourth fence section is added and tied with ropes to complete the corral.

Pup Captures

Individual pups may be captured during the first 2 or 3 d postpartum using the method described under noose captures for females. Later in the season pups may be captured independently of their mothers as they wander the peripheral areas of the rookery. The area covered by wandering 2-mo-old pups is considerable, and the chances of any given pup being on the inland border of the rookery at some time during the day are good. These animals are also captured with a long bamboo pole with a noose of light cord on the end. Sleeping pups are by far the easiest to capture. A pup running to escape capture can move down into the rookery faster than can a person carrying a long pole and who is trying to avoid causing a disturbance. Late in the season when disturbance is less important a small long-handled hoop net may be used for capturing pups.

When the rookery structure has largely broken down late in the season, large numbers of pups may be rounded up with portable fences in a manner similar to that used for subadult males, or for mass captures of females. Adult males and females on the rookery at this time of year can be driven off quite easily. To minimize the number of pups escaping into the water, plan carefully before the roundup begins. Two persons can handle a roundup and marking operation.

Pups up to 2-3 mo of age can be safely held up in the air by their hind flippers at arm's length. For longer trips place the free hand under the animal's chest, but still with arms outstretched. Pups have a surprisingly long reach, and if carried close to the chest can severely bite a person's shoulders, upper arms, or face.

Heavy gloves are required. Teams that mark large numbers (thousands) of pups extend their protection to the shoulder using a sleeve cut from a leather jacket. While marking 25 or more animals, minor nips are almost inevitable.

Short poles (1.5 to 2 m) are useful for herding groups of pups. Rigid sections of low fencing (1.5 m high) can be arranged in a U-shaped corral to hold groups of up to 25-30 pups. Inside these corrals the pups will crawl atop one another. This may allow some to escape over the top of the fence, and may cause some to suffocate at the bottom of the pile during the roundup. The animals should be driven back from the fence, or physically pulled off the top of the pile at frequent intervals. In extreme cases, lift the fence up and let the pups go toward the water

During the peak of pupping, northern fur seals will not flee from humans moving over their heads. For years wooden walkways (catwalks), elevated 2.5 to 3 m off the ground, have given researchers access to the centers of breeding groups to census, photograph, or collect animals for autopsy (Keyes 1965). We have recently used them as a platform to capture live pups for sexing, tagging, and growth studies.

Captures are made using a bamboo choker about 4 m long. From the squat position on the catwalk (to reduce alarm among females) lower the noose of the choker straight down. If the cord is so limp that the noose will collapse in this position stiffen the cord by wrapping tape around it. Using the end of the choker to move the pup around, arrange the noose so that it includes the pup's neck and one front flipper, and tighten by twisting. This placement of the noose encircles part of the rib cage and prevents closure of the trachea when the pup is lifted off the ground. With hand-under-hand motions lift the pup straight off the ground. This must be done very quickly to get the pup (and possibly its dangling placenta) out of the mother's reach before she can bite it. Quickly place the pup on the catwalk or have a second person catch it; dangling pups unwind the chokers and may fall.

Adult males often interfere with captures from a catwalk. Some will aggressively chase the choker and prevent the pup from being noosed. These animals can be distracted with a second choker, or by tossing pebbles as described in the section on female captures. Very few males will bite and toss dangling pups; simply avoid working near such males.

To minimize disturbance, capture only pups that are directly beneath the catwalk. If pups are noosed at some distance away from the catwalk (2-3 m), they cannot be lifted from there but must first be dragged beneath the catwalk. Mothers will chase pups that are dragged away, and the resident males will often chase the females. Great injury and disturbance can result from these chases. By the end of July or the first of August both females and pups are too wary of humans to permit further captures from a catwalk.

FEEDING OF CAPTIVE ANIMALS IN PERMANENT FACILITIES

Holding and feeding captive fur seals requires a considerable investment in time (particularly in the early stages), and usually results in less than 100% success with all animals. In planning for our needs for captives, we generally anticipate that 20 to 25% of those animals brought in will not learn to eat in captivity and will have to be released. Adult females should not be held longer than 8 or 9 d without food. Other researchers have also noted that some northern fur seals are slow to begin feeding in captivity (Bigg et al. 1977; Spotte 1980).

We keep herring and squid frozen at 0°F or below until the day of use. Protein breakdown in the thawed fish appears to be rapid which may decrease the nutritional value and reduces the acceptability of the food. No fish is kept frozen more than 1 yr. Although we have made no attempts to find out what the maximum consumption would be, we have found that females fed 5-7 kg of whole fish per day do not appreciably lose weight over a period of a month to 6 wk. Diet is supplemented by vitamin tablets ("Sea-tabs") specifically formulated for marine mammals. These tablets are inserted into the body cavity of a herring before it is fed to the seals. Because seals may pass the first food of the day through their systems quickly, (Kooyman[4]) we introduce the vitamin-supplemented fish sometime near the middle of the feeding session. Seals may not eat all the fish given in a feeding session and hence may miss a vitamin dose given late in the session.

During the first few days of captivity the animals are particularly sensitive to the presence and movement of nearby humans. To avoid this distraction, we generally try to stay out of sight of the animals during the first few feeding sessions. Our animals are trained to take dead fish while swimming. Animals are allowed into the feeding tanks and are given a few minutes to acclimate to the new surroundings. Then from a position out of sight (in the rafters above the tanks) fish are dropped one at a time into the water close to the swimming seals. For the first few sessions, interest in the food shown by the seals appears to be little more than curiosity. They may take the fish into their mouths, but generally do not eat. Occasionally a seal hauled out on a resting platform above the water may enter the water to investigate a fish dropped in the water nearby, but more typically this happens after the animals have learned to eat the dead fish.

The animals do not learn to accept dead fish at the same rate. At times it may prove valuable to experiment with putting a noneating seal in the same tank with a seal which has learned to feed (see also Spotte 1980). The amount of aggression displayed by different seals may vary widely. Once all the animals are eating, it may be necessary to keep more aggressive animals separate from less aggressive ones to more evenly distribute the food.

The amount of fish eaten and the portion of the fish consumed varies from day to day and among different seals. Sometimes only fish bodies are eaten; heads are bitten off and discarded. Occasionally seals will tear open the fish and consume only the livers. Most frequently we have seen animals eat entire fish for the first two or three offered on a given day, then begin biting off the heads and eating only the bodies. (This should be considered when fish are supplemented with vitamin tablets.) Seals usually begin by taking only one or two fish in the first feeding session. Good feeders rapidly increase to 3 or 4 kg per day in two or three sessions. Some appear to be insatiable, but if fed to satiation they will develop diarrhea and stop eating. It is best to increase the amount of food by a modest amount each day when a seal begins feeding.

Once the animals have begun to accept dead fish, the feeder may begin throwing fish into the tanks from a visible position. Eventually seals can be encouraged to eat at the near edge of the tank, and some will finally learn to take fish directly from he feeder's hand. The value of this training (especially if more than one seal is fed in a tank at one time) is that the amount of fish consumed by each animal can be monitored more accurately.

The degree of success with inducing seals to feed, and the amount of continued successful feeding may depend upon stresses placed upon the animals between feeding times. We recommend that the animals be disturbed as little as possible between feeding sessions for the first several days while they are still learning to accept dead fish in captivity.

One- and 2-yr-old subadult male seals have also been held in captivity and have learned to feed on dead fish. For experimental purposes these young males were taught to take fish while out of the water. This is not recommended as a normal procedure for feeding since animals choke on the loose scales.

LITERATURE CITED

BIGG, M. A., I. B. MACASKIE, and G. ELLIS.
1977. Studies on captive fur seals. Fish. Res. Board Can., Pac. Biol. Stn., Nanaimo, B. C., Manuscr. Rep. Ser. 1422, 29 p.

CHEVALIER-SKOLNIKOFF, S., and F. E. POIRIER
1977. Primate bio-social development. Garland Publ. Co., N.Y., 636 p.

GENTRY, R. L.
1975. Comaparative social behavior of eared seals. Rapp. P. -V. Réun. Cons. Int. Explor. Mer 169: 188-194.

GENTRY, R. L., and J. H. JOHNSON.
1978. Physical restraint for immobilizing fur seals. J. Wildl. Manage. 42: 944-946.

GRIBEN, M. R.
1979. A study of the intermixture of subadult male fur seals *Callorhinus ursinus* (Linnaeus 1758) between the Pribilof Islands of St. George and St. Paul, Alaska. M.S. Thesis, Univ. Washington, Seattle, 191 p.

HOBBS, L., and P. RUSSELL (editors).
1979. Report on the Pinniped and Sea Otter Tagging Workshop, 18-19 January 1979, Seattle Washington. Natl. Fish Wildl. Lab., Natl. Mus. Nat. Hist., Wash., D. C., 48 p.

JOHNSON, A. M.
1971. Recoveries of marked seals. *In* Marine Mammal Biological Laboratory, fur seal investigations, 1970, p. 26-31. Natl. Mar. Mammal Lab., Northwest and Alaska Fish. Cent., Natl. Mar. Fish. Serv., NOAA, Seattle, Wash.

KEYES, M. C.
1965. Pathology of the northern fur seal. J. Am. Vet. Med. Assoc. 147: 1090-1095.

KOOYMAN, G. L., R. L. GENTRY, and D. L. URQUHART.
1976. Northern fur seal diving behavior: a new approach to its study. Science (Wash., D. C.) 193: 411-412.

RONALD, K., and A. W. MANSFIELD (editors).
1975. Biology of the seal: proceedings of a symposium held in Guelph 14-17 August 1979. Rapp. P. -V. Réun. Cons. Int. Explor. Mer 169, 557 p.

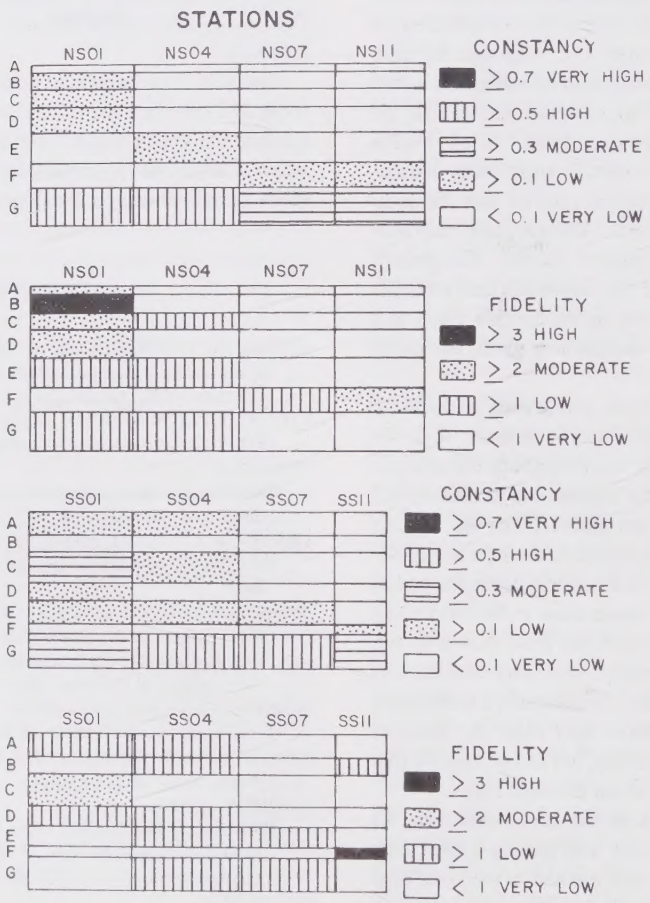
SPOTTE, S.
1980. Acclimation of adult northern fur seals (*Callorhinus ursinus*) to captivity. Cetology 36:1-8.

[4]G. L. Kooyman, PRL, Scripps Institution of Oceanography, La Jolla, CA 92037, pers. commun. February 1981.

ERRATA

NOAA Technical Report NMFS SSRF-757: A Profile of the Fish and Decapod Crustacean Community in a South Carolina Estuarine System Prior to Flow Alteration, by Elizabeth Lewis Wenner, Malcolm H. Shealy, Jr., and Paul A. Sandifer.

Page 7, Figure 3 is incorrect. See correct Figure 3 below.



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